The California Hydrogen Highway Network

Integrated Presentation and Overview

Public Meeting

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Reminders:

Questions and comments can be submitted during this session:

Webcast viewers: email to onair@arb.ca.gov

Live Attendees: fill out and submit form

California Hydrogen Highway Network: Core Values and Objectives

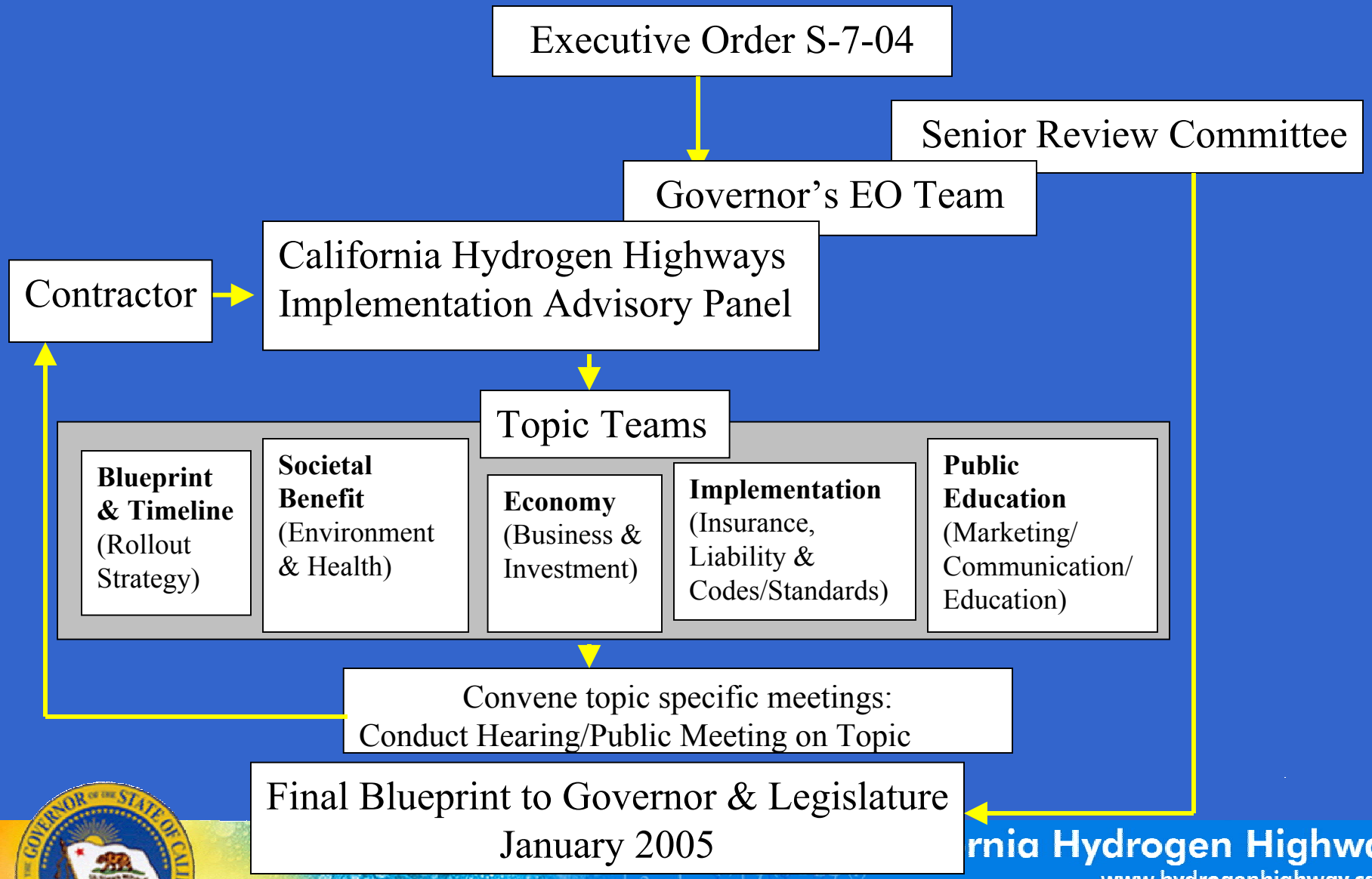
- **Promote energy independence**
- **Enhance energy security & diversity**
- **Reduce air pollution**
- **Reduce global warming emissions**
- **Protect public health**
- **Promote economic competitiveness**
- **Create jobs and business opportunities**

Note: for detailed background and mission statements: http://hydrogenhighway.ca.gov/

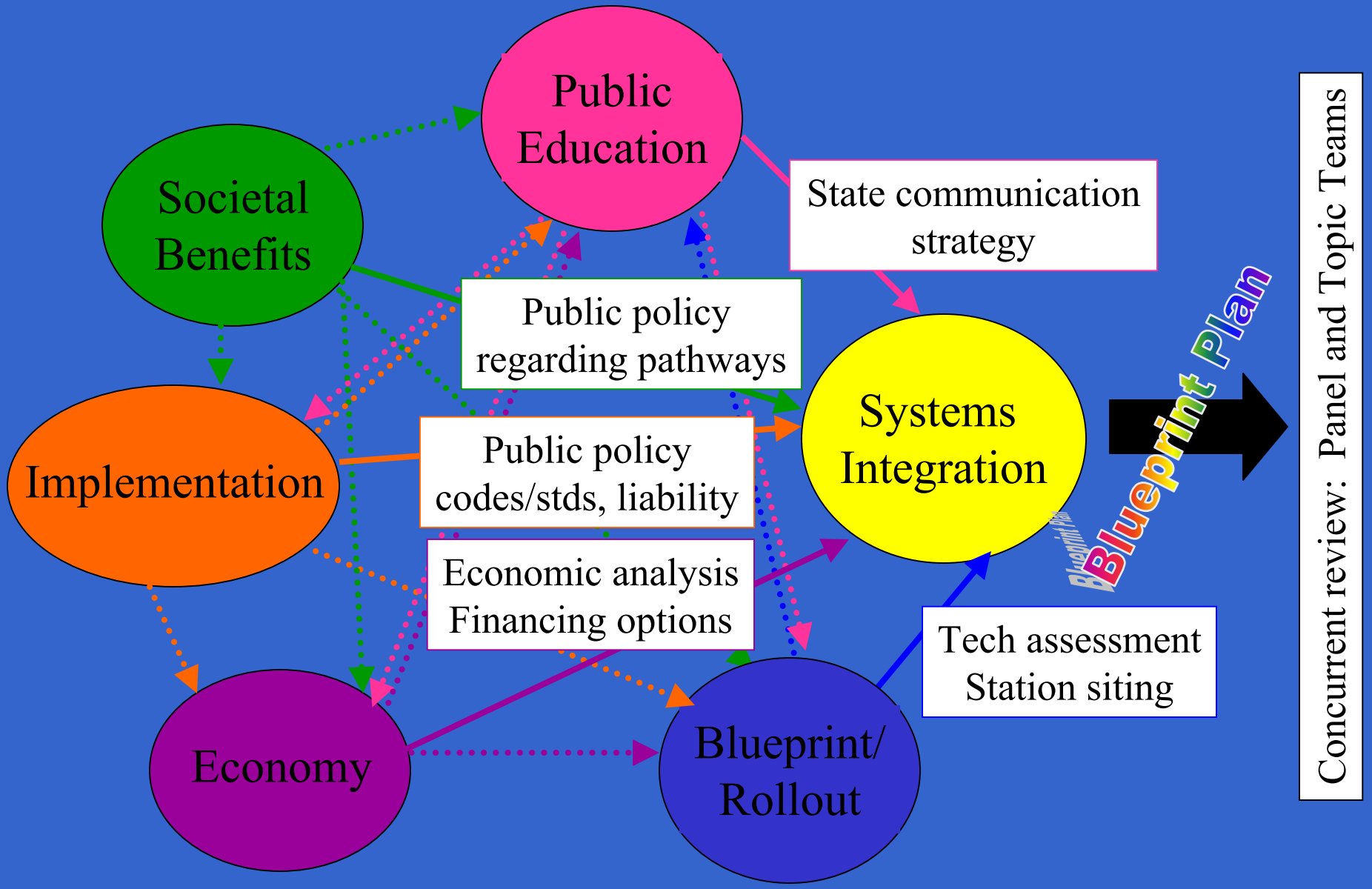
Measurements of Success

- Access to hydrogen fuel
- Significant and increasing percentage of renewable hydrogen
- Balance of commercialization pathways
- Public education program for hydrogen
- Commercially viable hydrogen vehicles & hydrogen-powered devices
- Hydrogen codes, standards, emergency response programs, training
- Ongoing research and development efforts
- New jobs and businesses

Operational Diagram



Interactions Among Teams



Summary: Overall Progress and Status

- Including today's earlier meeting, the Implementation Advisory Panel has now met five times.
- Each of the five Topic Teams has:
  - Conducted a public workshop.
  - Presented detailed findings to the Panel, and sought guidance on key issues.
  - Prepared a draft report, which is undergoing internal review.
- Final drafts of the Topic Team reports will be submitted to the EO Team on Nov. 5, 2004. These reports will be woven into a final, integrated "Blueprint Plan" report.
- A draft of the Blueprint Plan will be submitted to the Panel and Senior Review Committee on 12/01/04. The final version will be submitted to the Governor and Legislature by Jan. 1, '05.

Final Report Outline (Preliminary)

Volume I - Executive Summary

Volume II - California's 2010 Hydrogen Highway Network

Summary Blueprint Plan (Recommendations)

- Introduction
- Collaborative Process
- State of Hydrogen Technologies
- Benefits of Hydrogen
- Implementation Logistics and Issues
- Scenario Analyses
- Hydrogen Highway Implementation
- Public Policy Needed to Achieve Plan
- Public Education and Outreach

Final Report Preliminary Outline (cont'd)

Volume III - Appendices

Appendix A. Marketing, Communication and Education (Public Education Topic Team)

Appendix B. Codes and Standards, Insurance and Liability (Implementation Topic Team)

Appendix C. Societal Benefits of Hydrogen (Societal Benefits Topic Team)

Appendix D. Economics of Hydrogen (Economy Topic Team)

Appendix E. Blueprint Rollout Strategy (Blueprint Topic Team)

Progress Update on Topic Teams:

1) Blueprint Team
2) Societal Benefits Team
3) Implementation Team
4) Economy Team
5) Public Education Team

Progress Update on Topic Teams:

1) **Blueprint Team**
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Blueprint Team Goals

- Develop a plan that includes cost estimates, a timeline, and priorities to address how to develop and grow the California Hydrogen Highway Network
- Accelerate the commercialization of hydrogen in California as a fuel for vehicle and power-generation technologies
- Help build on California's lead in hydrogen and fuel cell technologies with a multi-phased approach towards sustainable commercialization

Blueprint Team: Subgroups

- Production and Delivery - availability, commercial readiness, barriers, environmental considerations, etc. for various options
- Applications - vehicles, stationary fuel cells and energy stations
- Sites - station locations, relation to existing facilities and end users, access to renewable energy, etc.
- Commercialization - customer pull, technology push

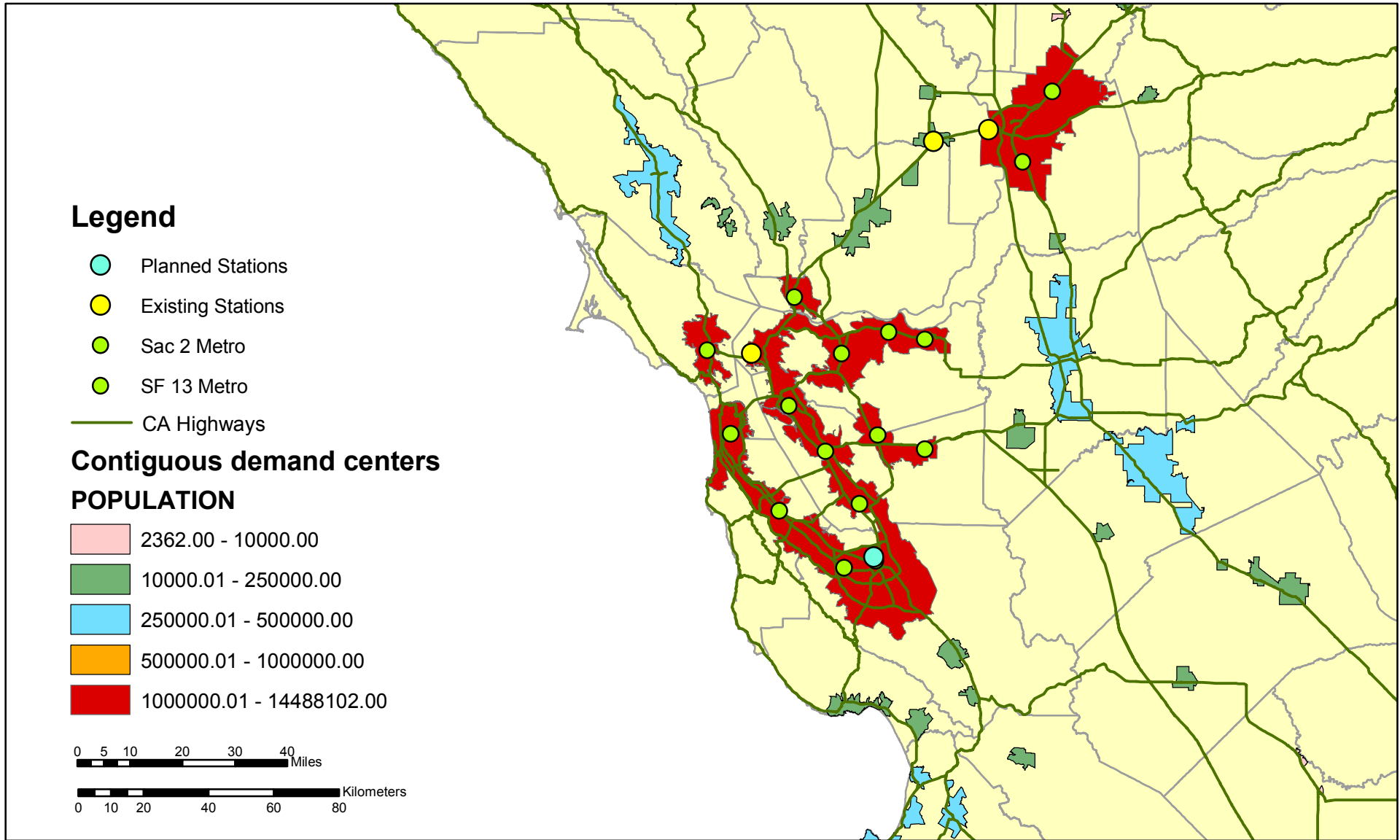
Blueprint Team: Summary of Progress

- Each of the four sub-groups are now completing their respective sections of the draft report
- The Production and Delivery Subgroup is evaluating various hydrogen production options, including those involving renewable energy sources
- The Applications Subgroup is reviewing, cataloging and analyzing potential hydrogen-powered applications (mobile and stationary) over three different timeframes
- The Sites Subgroup is establishing detailed hydrogen station selection and siting criteria, and developing illustrative station maps under each of three CA Hydrogen Highway scenarios (A, B and C)
- The Commercialization Subgroup is identifing various “customer pull” and “technology push” activities and policies that will help accelerate commercialization
- Progress in these sub-group areas was presented to the Advisory Panel at today’s meeting

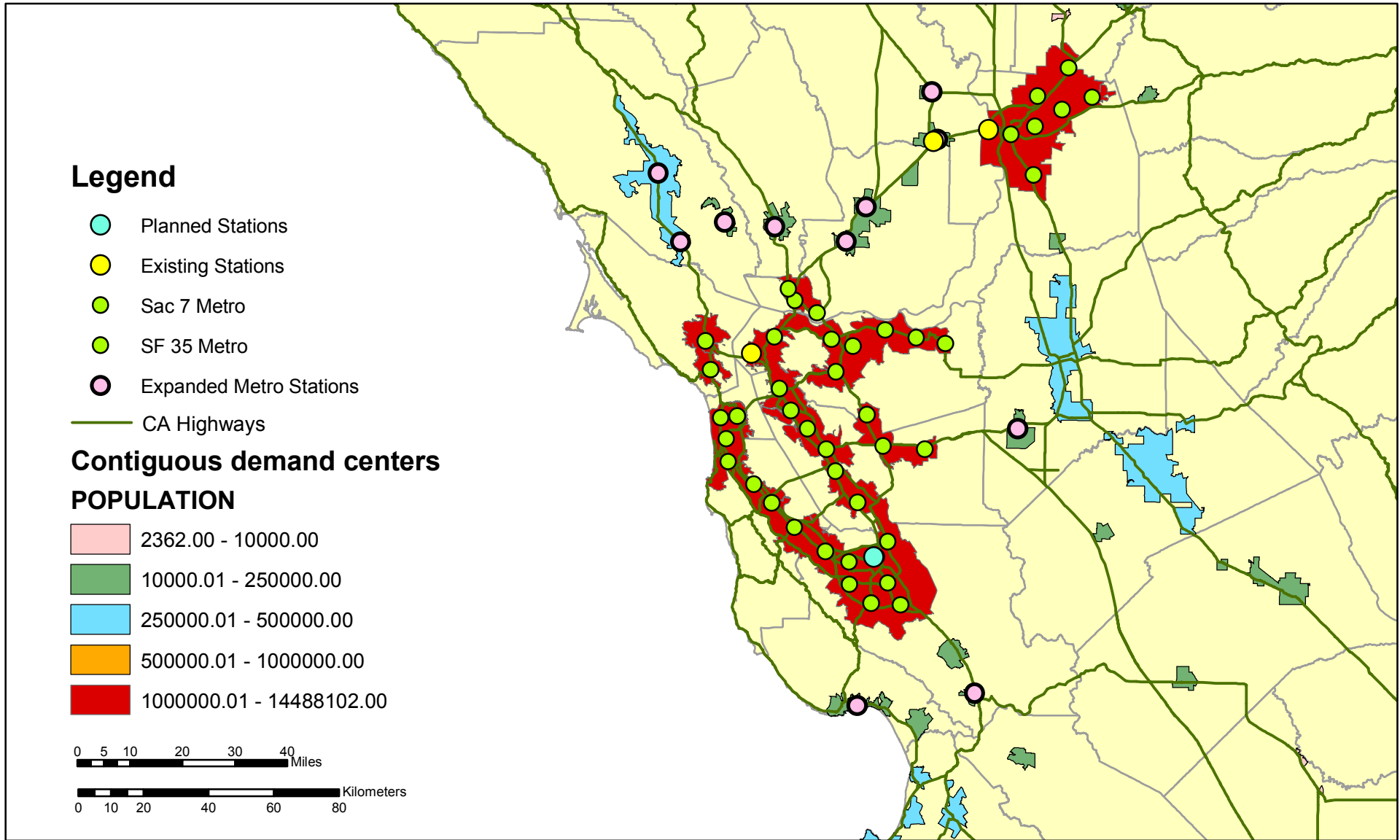
Sites Subgroup

- Establishing Siting Criteria
  - Leveraging off existing resources (CNG, DG, site characteristics)
- Developing illustrative maps for bounding exercise
- Three scenarios:
  - 50 stations
  - 150 stations
  - 250 station
- Maps are non-specific on technology and capacity; based solely on demographics

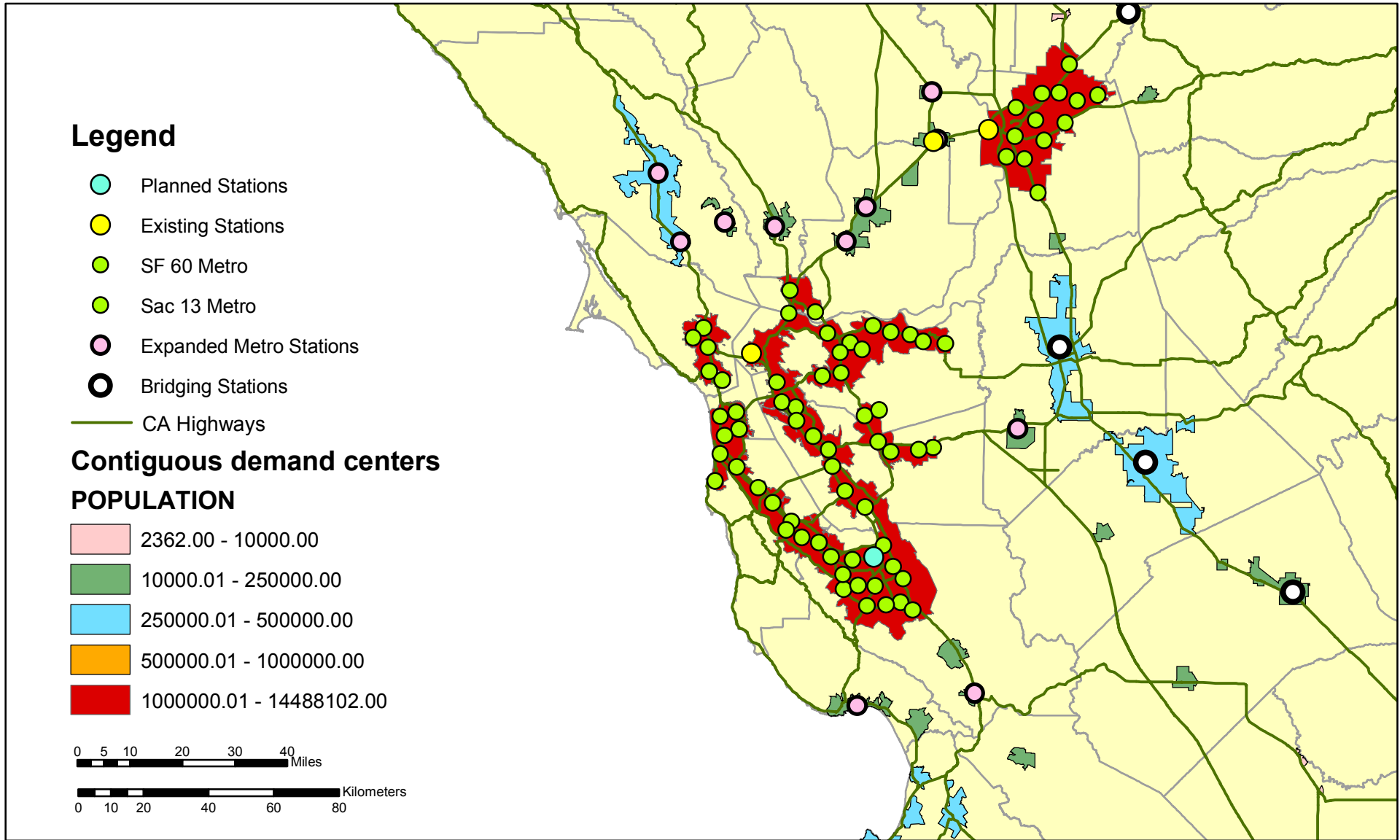
Example Maps: Scenario A for Northern California



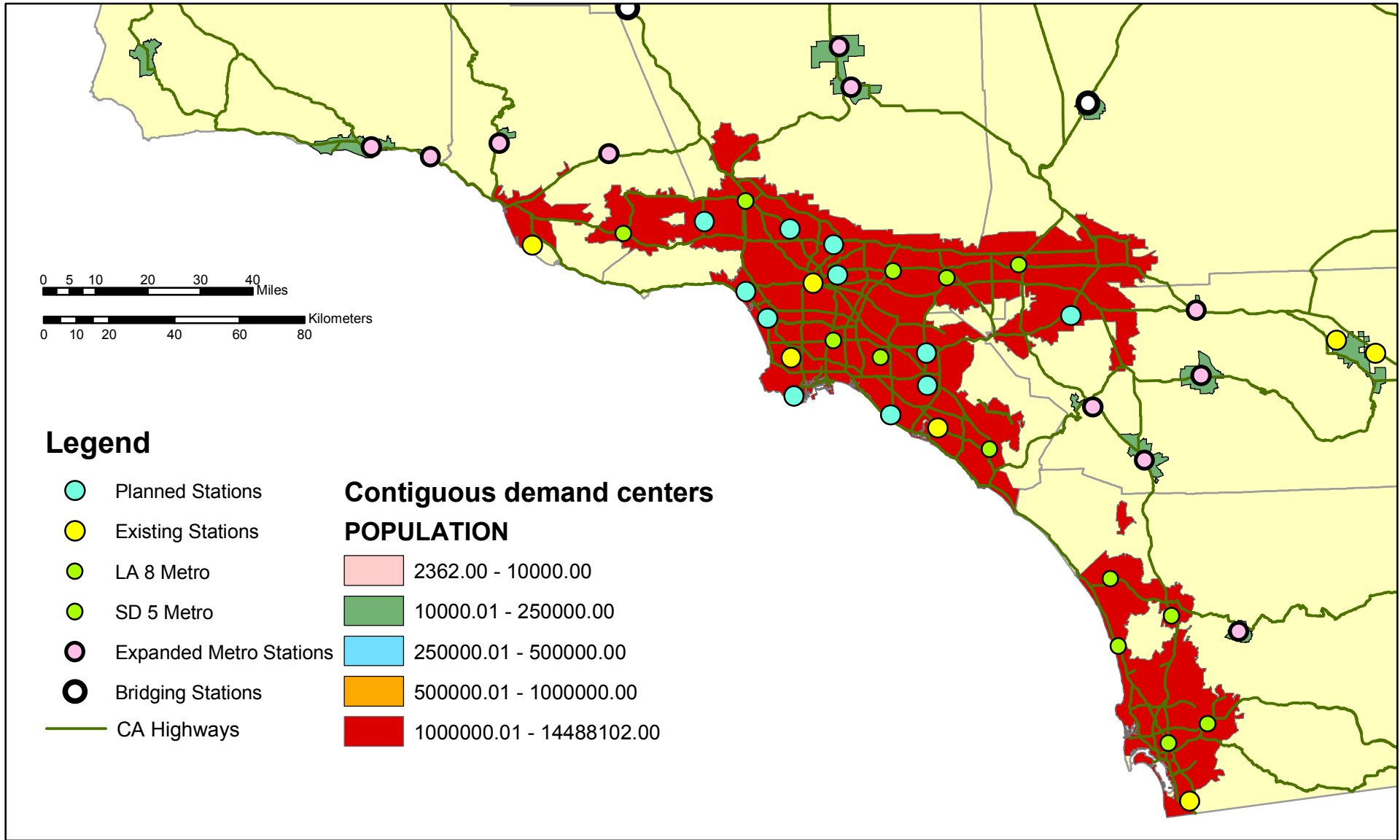
Scenario B: Northern California



Scenario C: Northern California



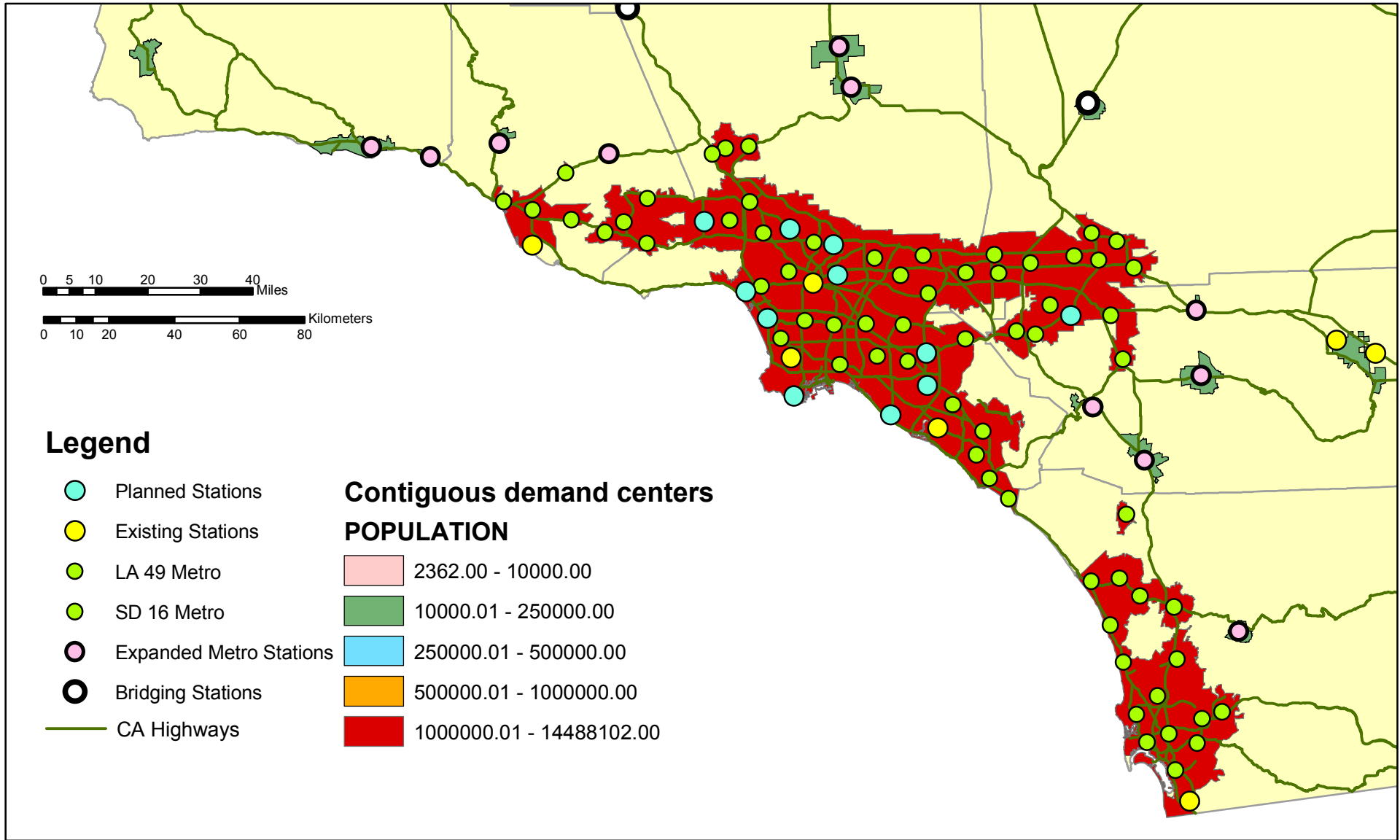
Scenario A: Southern California



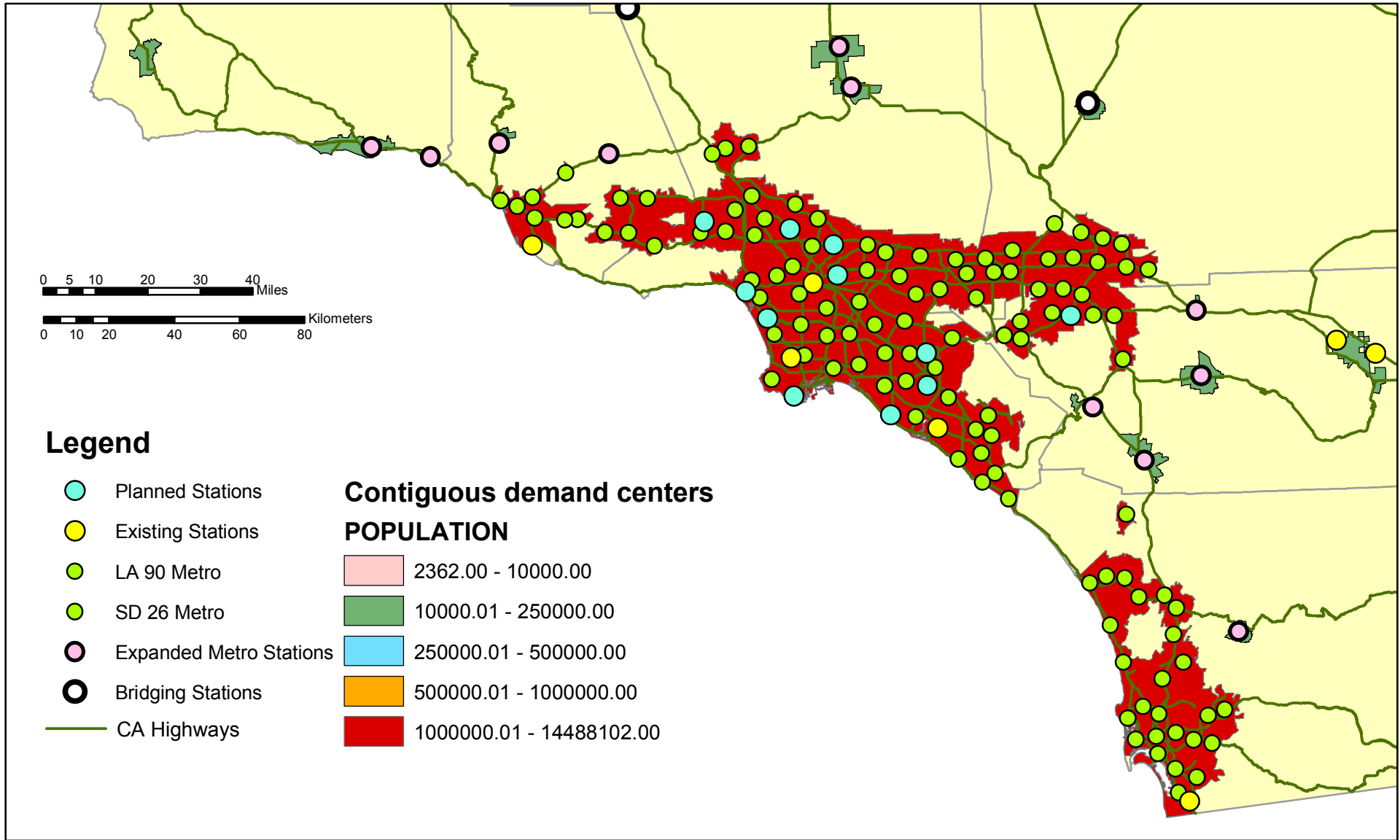
Newest CA H2 Net Station

LAX October 22, 2004

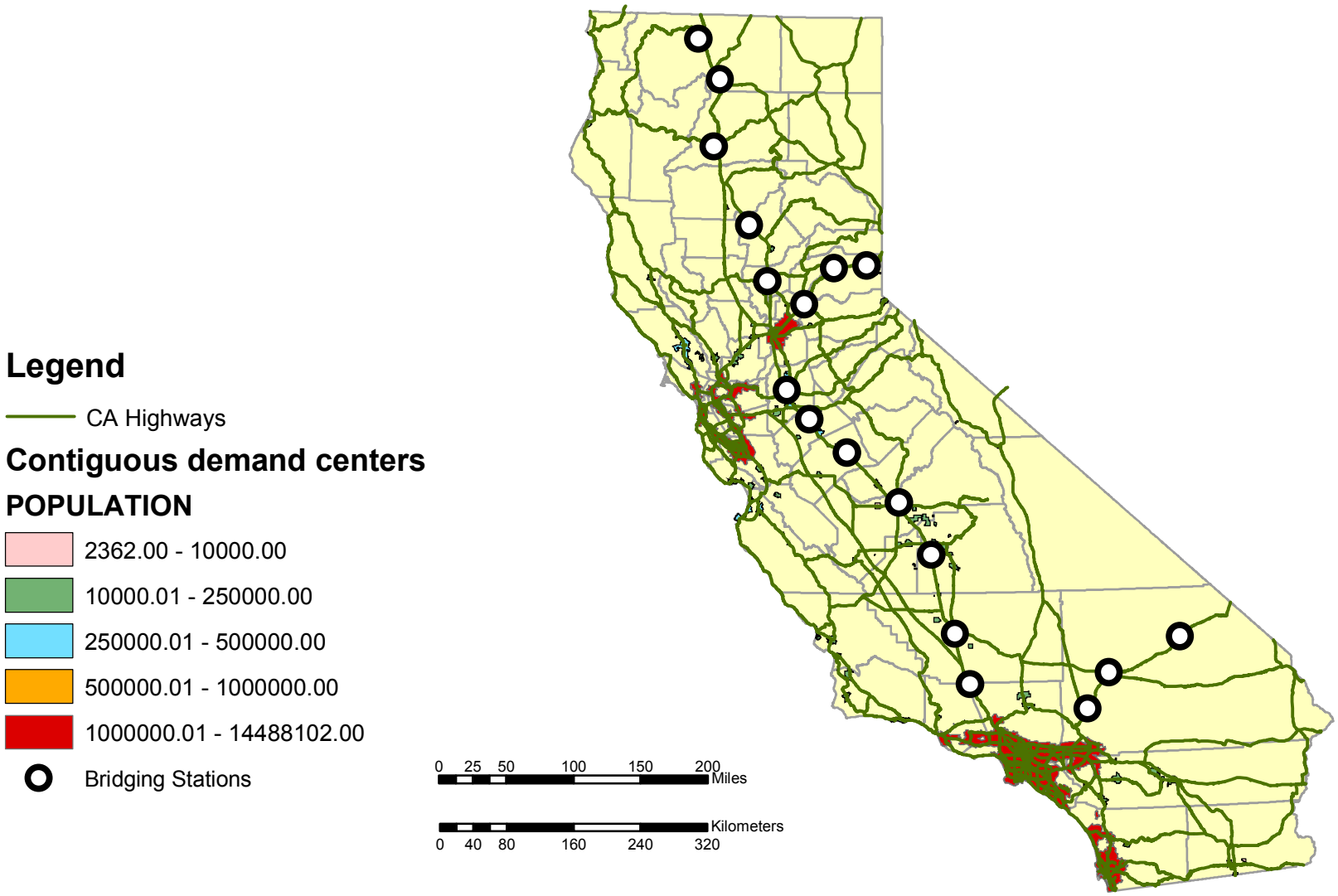
Scenario B: Southern California



Scenario C: Southern California



Scenario C: Bridging Stations



Progress Update on Topic Teams:

1) Blueprint Team
2) **Societal Benefits Team**
3) Implementation Team
4) Economy Team
5) Public Education Team

Societal Benefits Team: Summary of Progress

- Developed hydrogen pathways and station mix estimates under Scenarios A, B and C
- Assessed the appropriate role of renewable energy sources, and how to achieve progressively higher percentages of renewables
- Established key goals
  - 30% reduction in aggregate well-to-tank green house gas (GHG) emissions
  - 20% of hydrogen produced from renewable energy sources

Examples of Hydrogen Production Pathways

Energy Carrier	Central Plant Production	Delivery	On-Site Production	Compression Option	Consider Sequestration
Renewable Power			Electrolysis	420 bar cascade	--
	Electrolysis	Tube trailer	--	420 bar cascade	--
Grid Power			Electrolysis	420 bar cascade	--
Natural gas	Steam reforming, Existing LH2 plant	LH2 Truck	--	420 bar cascade	--
	Steam reforming	Mobile fueler	--	420 bar cascade	yes
			Steam reforming	420 bar cascade	--
Petroleum Coke	Pyrolysis to H2	Mobile fueler	--	420 bar cascade	yes
Biomass (Ag waste)	Pyrolysis to H2	Mobile fueler	--	420 bar cascade	yes

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Implementation Team: Summary of Progress

The Team has completed its draft report addressing a wide variety of related issues, e.g.:

- Collection of existing codes and standards regulating hydrogen use in California
- Identification of gaps, areas of overlap, or insufficiencies within the existing body of codes and standards
- Potential recommendations to the State to resolve inadequacies in existing codes, standards, permitting processes; and vehicle-station interface
- Issues pertaining to securing insurance for hydrogen facilities; and accepted methods of risk assessment and management

Progress Update on Topic Teams:

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4) **Economy Team**
5) Public Education Team

Economy Team: Summary of Progress

- A detailed station cost model has been prepared, using established station mix scenarios
- Key assumptions are built into the model, as derived from Topic Team members and other stakeholders
- This model was used to estimate total costs for the CA Hydrogen Highway under each Scenario (A, B and C)
- Estimated costs for each scenario include:
  - Annual (amortized) station costs (capital, O&M in MM$/yr)
  - Hydrogen vehicle costs ($/vehicle)
  - Hydrogen fuel price ($/kg)

Economy Team Progress (continued)

- "Scenarios for success" have been envisioned, and sensitivity analyses have been performed, to help leverage existing resources and identify pathways to the most-favorable economics
- Estimated results on an annualized cost basis as well as Capital, Operating, $/kg:
  - Scenario C baseline results are $34 MM/yr
  - Site selection, station choice, and other parameters result in $29 MM /yr +/- $5 MM range
- Economic externalities (e.g., the cost of adverse health effects from today's petroleum-based transportation sector) are also being estimated, in conjunction with the Societal Benefits Team
- These preliminary results were presented to the Advisory Panel at today's meeting, and will undergo further review / revisions

The Economy Team is Looking at Options to Fund the Hydrogen Highway Network

- Private Funding: the private sector / industry will use its own capital to build hydrogen stations and related infrastructure.
- Public Funding: any method of funding that affects the revenues earmarked for the State budget.
- A combination (public-private partnership) of the two.

Examples of Public Funding Options

- Cross Subsidies, e.g.:
  - Redirect a small share of excise fuel tax
  - Redirect a share of CPUC “Public-Purpose” surcharge (allow utilities to spend the funds on transportation projects)
  - Use a share of AB2766 funding
- New Subsidies, e.g.:
  - Issue general obligation bonds (used to finance public capital projects)
  - Revenue bonds (may not be possible, because they require revenue streams)
  - Increase vehicle registration fee
  - Establish hydrogen grant program (similar to Moyer)
  - Provide tax credits to reduce costs of R&D investments

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Public Education Team: Summary of Progress

- Defined overarching goals
- Described core message
- Defined a detailed communications process
- Established immediate communication needs
- Identified target audiences and sub-audiences
  - Technology and industry enablers
  - Government, policy makers and influencers
  - Consumers and customers
  - Education community
- Developed detailed outreach recommendations for each targeted audience

Public Ed. Team's Overarching Goals

- Enhance and build upon State's reputation as a world leader in hydrogen technologies, alternative fuels and environmentally benign transportation technologies
- Foster widespread public understanding and support for hydrogen
- Foster policy support that can incentivize hydrogen technology manufacturing
- Develop programs and mechanisms for training of the needed workforce
- Create consumer demand for hydrogen fuel and end-use devices (vehicles, stationary fuel cells, other)

Public input, questions and comments are welcome!

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